NATIONAL BUREAU OF STANDARDS REPORT

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Development, Testing, and Evaluation of Visual Landing Aids

Consolidated Progress Report
to
Ship Installations Division
Bureau of Aeronautics
Department of the Navy
Washington 25, D. C.

For the Period
April 1 to June 30, 1957

For
Bureau of Aeronautics Projects

TED No. NBS-AE-10002
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U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

Development, Testing, and Evaluation of Visual Landing Aids

April 1 to June 30, 1957

I. REPORTS ISSUED

Report No.	Title
5243	Maintenance of Airfield Lighting Systems. Part III, Troubleshooting Procedures for Series Circuits
5294	Photometer for the Measurement of the Effective Intensity of Condenser-Discharge Lights
5305	Development, Testing, and Evaluation of Visual Landing Aids, Consolidated Progress Report for the Period January 1 to March 31, 1957

II. RESEARCH AND DEVELOPMENT, LABORATORY TESTING, AND CONSULTATION SERVICES IN CONNECTION WITH VISIBILITY, AIRFIELD LIGHTING, AND FOG MODIFICATION PROBLEMS (TED NBS-AE-10002).

a. Visibility Meters and Their Application.

A preliminary report has been received from Mr. R. A. Halverson, Supervising Electronics Technician, Weather Bureau 4th Region, giving the results of the use of the experimental transmissometer calibrator which was loaned to him for service test. Mr. Halverson reports that the calibration procedure is relatively easy and convenient. He reports that the calibrations obtained with the experimental unit when the visibility was in the 3 - 5 mile range (night) differed by less than 1% from the calibrations obtained in good visibility by the usual extrapolation procedure at both Ontario and Los Angeles, California.

A service-test quantity of phototubes designed specifically for transmissometer use has been obtained from the Continental Electric Company, Geneva, Illinois. These tubes are designated as type XR-711-1 and are now available commercially as type CE-75. The average sensititivey of this group of tubes is approximately 1.5 times that of a group of type 919 phototubes tested in 1955 and the average dark current is less than one-tenth that of the type 919 group.

Every tube in the group meets the requirements for phototubes given in Section 6.3 of NBS Report 4436. It should be noted that the cathode of the type XR-711-1 tubes is connected to pin 3 of the tube base instead of pin 2 as is done with type 919 tubes. Hence a jumper should be connected between pins 2 and 3 of socket X101 in the pulse amplifier so that these tubes can be used. No other changes are necessary.

b. Airfield Lighting and Marking.

Materials for Marking Runways. Some of the mechanical tests of the materials being considered for runway markings have been completed. The results are tabulated below. Table I shows the quantitative results of the plasticity tests. Table II shows the qualitative results obtained on the abrasion resistance, weather-ometer, and impact adhesion tests.

Table I

Quantitative Results of Plasticity Tests

Plasticity Tests		Time	Average of 3 Samples Each Nefslabs	Crystalex
McBurney Indentation	Before Weathering	(1 min.	0.0285	0.0158
		(10 min.	.0322	.0360
	After Weathering	(1 min.	.0316	.0142
		(10 min.	.0354	.0321
Shore Hardness	Before Weathering	---	93	96
	After Weathering	---	93	92

Table II

Qualitative Evaluation of Effects of Indicated Tests

Tests	Plastic Materials		Paints		
	Nefslabs	Crystalex	Traffic	Masonry	Heat Resistant
Abrasion Resistance 200 revolutions w/ 20-pound load	Considerable wear	Deposit of rubber abraders	Best	Some deeply gouged areas	Poorest
Weatherometer u.v. radiation and 1 daily rinsing, 40 days (equivalent to 1.5 years of natural weathering)	No significant change	Surface smoothened by flow	Whitened	Yellowed	No significant changes
Impact Adhesion	No crack	Not tested	Not tested	Not tested	Not tested

Materials for Background of Runway Distance Markers. Measurements were made of the fading of the colors on exposure to weathering of several different materials. Several plastic foam materials supplied by the Bureau of Aeronautics were exposed to weathering at the National Bureau of Standards. These were red-dyed and green-dyed, and blaze-orange painted and fire-orange painted "Styrofoam" panels, and blaze-orange painted "Dylite." Colorimetric data were taken at the start and after 3-month, 5-month, and 8-month periods of exposure. The results of these measurements are given in table III.

Wooden test panels painted with NRL Formula A7 fluorescent paint have been prepared and exposed at four Naval Air Stations and are being forwarded to the National Bureau of Standards for colorimetric measurement in accordance with Bureau of Aeronautics instructions. Unexposed panels and panels exposed to weather for 3 and 6 months have been received to date. The results of the measurements of these panels are given in table IV.

Table III

Color Changes of Materials Exposed at the National Bureau of Standards

Material	Reflectance			Chromaticity Coordinates x			Chromaticity Coordinates y		
	Initial	Change After 3 Months	Change After 8 Months	Initial	Change After 3 Months	Change After 8 Months	Initial	Change After 3 Months	Change After 8 Months
Styrofoam green dye	19.4	-4.4	- 5.6	0.270	+.007	-.006	0.359	-.001	+.009
red dye	16.3	+2.0	+15.2	.453	-.051	-.075	.306	+.034	+.052
fire orange fluorescent paint	20.8	+2.1	+16.1	.620	-.106	-.234	.324	+.038	+.058
blaze orange fluorescent paint	32.8	-3.6	- 1.1	.618	-.021	-.062	.350	+.009	+.033
Dylite blaze orange fluorescent paint	+26.9	-1.8*	---	.641	-.035*	---	.344	+.021*	---

* After 5 months.

Table IV

Color Changes of Test Panels Exposed at Four Air Stations

Air Station	Reflectance			Chromaticity Coordinates					
				x			y		
	Initial	Change After 3 Months	Change After 6 Months	Initial	Change After 3 Months	Change After 6 Months	Initial	Change After 3 Months	Change After 6 Mohths
Quonset Point	25.1	-4.1	-0.7	0.614	-.011	-.048	0.327	+.005	+.017
Miramar	26.7	+ .4	+4.8	.603	-.007	-.043	.325	+.006	-.001
Atlantic City	17.4	-6.8	--	.647	-.018	--	.325	+.009	--
Sanford	18.1	--	+2.3	.640	--	-.046	.318	--	+.026

The data of tables III and IV show that:

1. The Styrofoam panels with the green dye became darker on exposure, but suffered no appreciable change in other color aspects.

2. The Styrofoam panels with the red dye became much lighter and much less saturated in color, that is, almost neutral.

3. The panels coated with the fluorescent paint generally became lighter, lost color saturation, and shifted toward yellow from red or orange. The fluorescence of the paints was greatly reduced after 6 months exposure.

c. Seadrome Lighting.

Sea-Lane Marker Lights. An order has been placed with the General Electric Company for a service-test quantity of 500-watt, 20-ampere lamps for this light.

A conference was held with representatives of A'G'A Division of Elastic Stop-Nut Corporation who have the contract to supply 60 sea-lane marker lights, Kopp Glass Company, who are making the lenses for these lights, and the General Electric Company, who are developing the lamps for the lights. It was decided that the lamp should have a T-24 bulb, a C-8 filament with a spiral support to eliminate shadows, and a collector grid to reduce the effects of bulb blackening. The light will consist of a cylindrical fresnel lens which will fit on the castings of the type MB-1 light.

Approach-Light Lamps. An order for a service-test quantity of 500-watt, 20-ampere, approach-light lamps has been placed with the General Electric Company.

Corner-Identification Lights. The identification lights have been modified to use the series-motor drives described in the report for the last Quarter, and are now ready for installation.

d. Carrier Lighting and Marking.

A check on the compatibility of the intensity characteristics of the feasibility model of an optical glide path indicator developed by Burroughs Research Corporation and datum lights consisting of type 399 PAR approach-light lamps with green filters was made by observing the indicator and datum lights from distances of 600 and

3000 feet under low-level daylight, twilight, and night conditions. The intensities of the indicator and of the datum lights were adjusted independently for optimum appearance. The observations indicate that independent intensity control of the two types of lights will not be necessary.

A feasibility model consisting of one cell of an optical glide path indicator has been received from the Perkin-Elmer Corporation. A complete indicator would consist of 14 identical cells arranged in an array 7 cells high by 2 cells wide. The projection system of the cell consists of a spherical first surface mirror approximately 7.5 x 7.5 inches with a focal length of 20.78 inches. A type 18A/T10/2P ribbon-filament lamp is positioned in front of the mirror so that the mirror forms a virtual image of the lamp filament 150 feet behind the mirror. A cylindrical lens array in front of the lamp provides horizontal beam spread. The over-all dimensions of the cell are 30 x 8 x 8 inches. The weight is 14 pounds.

Intensity distribution measurements were made of this unit. The results of these measurements are shown in figures 1 and 2. A photocell with a diameter of 1-3/4 inches was used as a receiver. A photometric distance of 100 feet was used. This is less than the distance at which the measured intensity becomes independent of distance. Hence the intensities are somewhat a function of the conditions of measurement. Angles of elevation are computed from a point 150 feet behind the unit using the plane which is parallel to the top of the unit and passes through its center as the origin. Angles of azimuth are measured from the face of the unit.

e. Lights for Carrier Deck Personnel.

The initial production set of the LSO lighted suit equipment was reviewed and is now undergoing evaluation. Although previously requested changes have been incorporated, additional modifications appear necessary. A conference with the contractor is being arranged to work out final details for incorporation in subsequent production.

A conference with Captain Wagner of the Naval Medical Research Institute and Commander Ogle of the Bureau of Aeronautics has led to the conclusion that the wands now used in deck taxi-guidance lights and those in our improved experimental version are too heavy. Accordingly, our model is being redesigned to lighten the hand-held

ward. It was further decided that one equipment would be made and demonstrated to the fleet before construction of 12 sets for general fleet evaluation.

f. General Laboratory and Consultive Services.

Photometry of Flashing Lights. A formal report describing the system developed for the photometry of flashing lights producing short, repetitive flashes has been prepared and released. This system is directly applicable to sources having flash durations of less than about 0.01 second and can often be applied to lights producing flashes with durations longer than 0.01 second (NBS Report 5294). This report and NBS Report 4554, "Computation of the Effective Intensity of Flashing Lights," are being prepared for publication in Illuminating Engineering.

g. Personnel.

Mr. David B. Sirota, GS-5, who was on leave while attending school, entered on full-time summer duty June 17, 1957.

III. VISIBILITY AND BRIGHTNESS TESTS, SURVEYS, EVALUATION AND ANALYSIS OF VISUAL LANDING AIDS, BASIC TESTS AND EQUIPMENT, AS A FIELD SERVICE AT ARCATA, CALIFORNIA (TED NBS-AE-10011).

a. Airport Lighting and Marking.

Approach Beacons. Two approach beacons are being assembled for installation at MCAS El Toro. Before starting assembly of these units a check was made to see if the units installed at Arcata were being used routinely. Several airline and local pilots requested that these units be retained at Arcata, stating that they use them during marginal conditions, especially during twilight and at night. A parts list and a circuit diagram of the Arcata installation was prepared for use in planning service-test installations. This installation uses standard 240/120//24/12 volt transformers connected in a buck-or-boost arrangement to obtain a two-step intensity control and to compensate for line drop. Although the performance of this arrangement is entirely satisfactory, it appears unduly complicated for general use. Hence quotations have been asked for a special transformer with intensity-control and line-drop compensating taps in accordance with the following requirements:

The intensity control assembly for approach beacons shall consist of a transformer, either a double-winding or an autotransformer, and a contactor to select one of two output voltages.

The load to be connected to the assembly consists of six 399-watt, 120-volt lamps and a 120-volt, one-sixth horsepower induction motor. The nominal input voltage is 240 volts. Three input voltage taps, for inputs of 200, 220, and 240 volts shall be provided.

The output of the transformer shall be tapped for output voltages of 50, 60, 75 and 120 volts. All taps shall be brought out to suitable terminal strips.

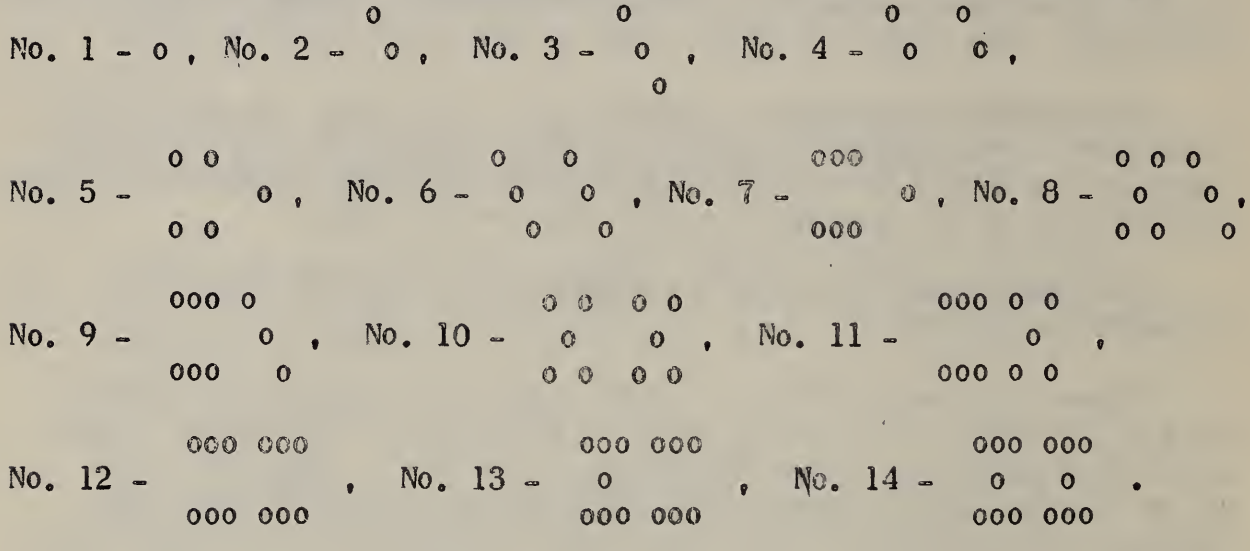
A contactor which will be used to connect either of two of the four possible output voltages to the lamp load shall be supplied. When delivered the contactor shall be connected to supply 70 volts to the lamps when unenergized and 120 volts to the lamps when energized. The contactor shall have a 120-volt operating coil.

The current required to operate this coil shall be the minimum consistent with reliable operation. The contacts of the contactor shall be so linked mechanically that simultaneous connection to two output taps of the transformer will not be possible.

The entire assembly shall be housed in a case suitable for exposure to weather.

Runway Distance Markers. Tests have been made of the effect of the location of the light which illuminates the distance marker upon the legibility of the figure on the marker. When the light is on or near the vertical plane through the center of the mark, the specular reflection from the orange background of the mark reduces the contrast with the figure and the legibility distance is about 100 feet less than it is when there is no specular reflection in the direction of the observer. Moving the light so that it is nearly in line with the edge of the mark toward the runway eliminates the effect of specular reflection but in this position the light itself is visible and causes glare over a considerable area of the runway. Locating the light near the outboard edge of the runway places the zone in which there is specular reflection in the direction of the pilot close enough to the sign so that the loss in contrast causes no problem. This location, of course, minimizes the area of the glare zone on the runway but may produce glare on taxiways paralleling the runway.

Tests were also made at night of a dot sign of the type described in the Progress Report for January - March 1957. Red lamps were installed on the sign. These consisted of 3-candlepower, 6-8-volt automotive lamps mounted in holders with red plastic beehive lenses. The test was conducted by placing a stationary observer at specified distances, presenting a series of configurations, and determining the accuracy with which they can be detected. The results were as follows. On a clear, moonless night, visibility 8-10 miles, with the observer at 2000 feet, accuracy of recognition was 100%. With the observer at 2500 feet, recognition was 80% correct. The lamps were operated at 5.8 volts for these tests. With the voltage at 6.8, conspicuity was increased. However, the intensity was too high and the sign was uncomfortable to observe. The intensity at 4.6 volts was comfortable, but the range was considerably reduced. Figures preferred as being more readily detectable are as follows:



Using these figures, it is not necessary to be able to count the individual number of lights to recognize the figure, as the legend can be readily recognized from the shape of the figure. It is suggested that the dot sign should be investigated further as a possible means of increasing the range of distance markers well above the range of present systems.

b. Electrical Engineering.

Survey Trip. The report of the survey trip to seven California Naval and Marine Air Stations has been drafted and is being reviewed.

Maintenance Manual. The section of the Airfield Lighting Maintenance Manual covering troubleshooting has been issued as NBS Report 5243, "Maintenance of Airfield Lighting Systems, Part III, Troubleshooting Procedures for Series Circuits." Comments on this report will determine what troubleshooting procedures will be included in the final Manual. The survey trip made last year indicated that brief troubleshooting procedures are generally preferred. Work on the other sections of the Manual will resumed next quarter.

Cable Tracing. Both the preproduction model and a production TSM-11 Cable - Test Detecting Set have been returned to the manufacturer in accordance with Bureau of Aeronautics instructions for replacement of the defective electrolytic capacitors with tantalum capacitors. It is hoped that the sets will be returned before the rainy season starts so that checks of their performance can be made under the more difficult dry conditions when the resistance to ground of faults is high.

c. Research on Visibility and Visibility Measurements.

Effective Intensity of Flashing Lights. Reduction and analysis of the data obtained to date for the report, "Effective Intensities of Flashing Lights" has been completed and the first draft of the report has been prepared. Additional determinations of the effective intensity of a Westinghouse krypton light in low visibility conditions are needed for the completion of the report.

Slant Visibility Meter. The slant visibility meter was inoperative this quarter as the receiver scan drive mechanism is being reworked in Washington.

Brightness Meters and Illuminometers. The scan drive mechanisms of the horizon-sky brightness meters are being reworked in Washington. The drive mechanism of the shadow bar used to obtain measurements of the ratio of direct to indirect illumination was reworked to replace corroded and worn parts and to provide a counterweight so that the shadow arm can be rotated without external support.

Transmissometers. Development of modified bridge circuits for transmissometer indicators has been completed. These bridges use a triode tube in place of the voltage-regulator tube in the bridge. The modified circuits appear more stable than the present circuits. Their performance is now being observed over an extended period in

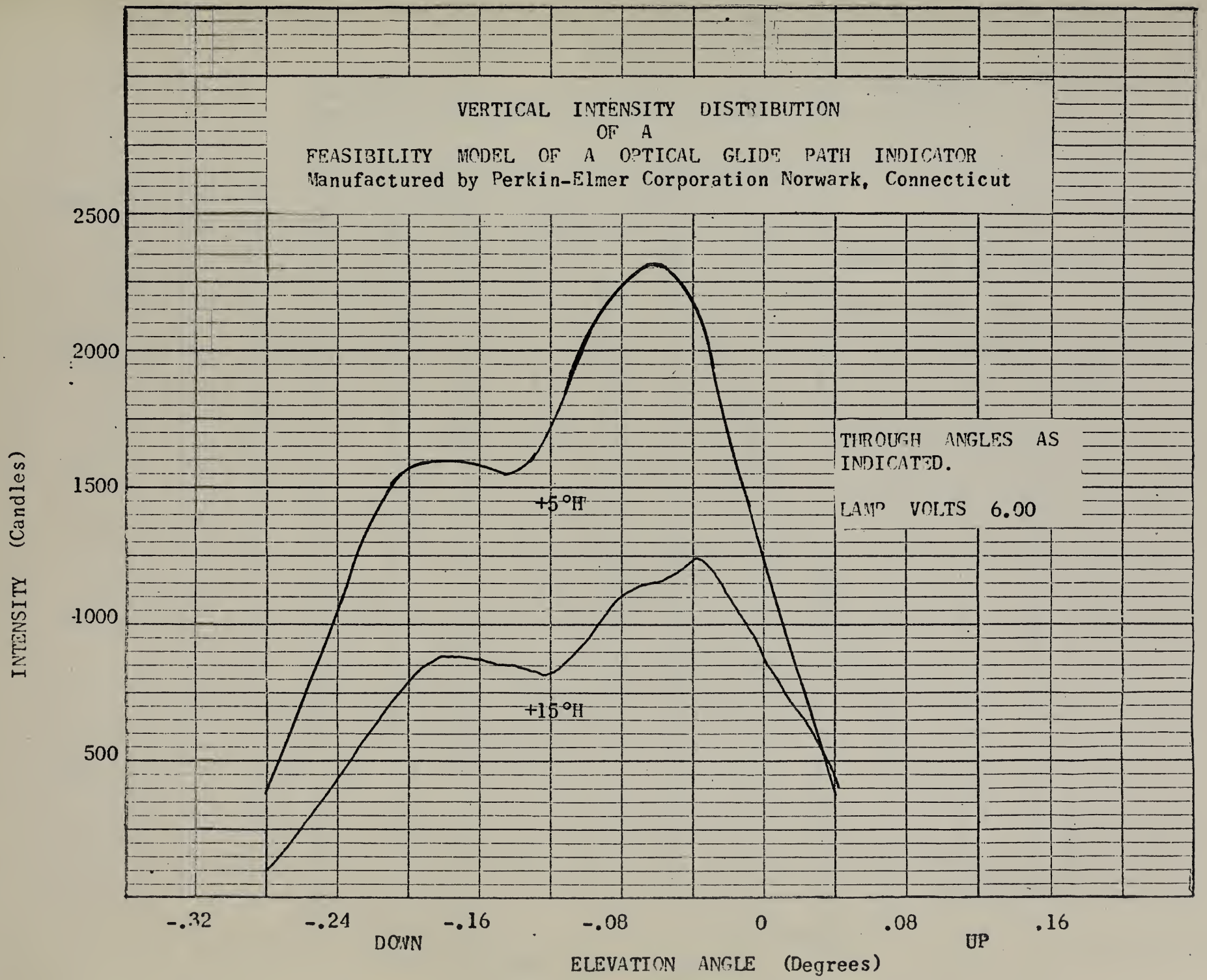
order to obtain comparative data on drift and tube life. A report giving the results of the work to date has been prepared and reviewed.

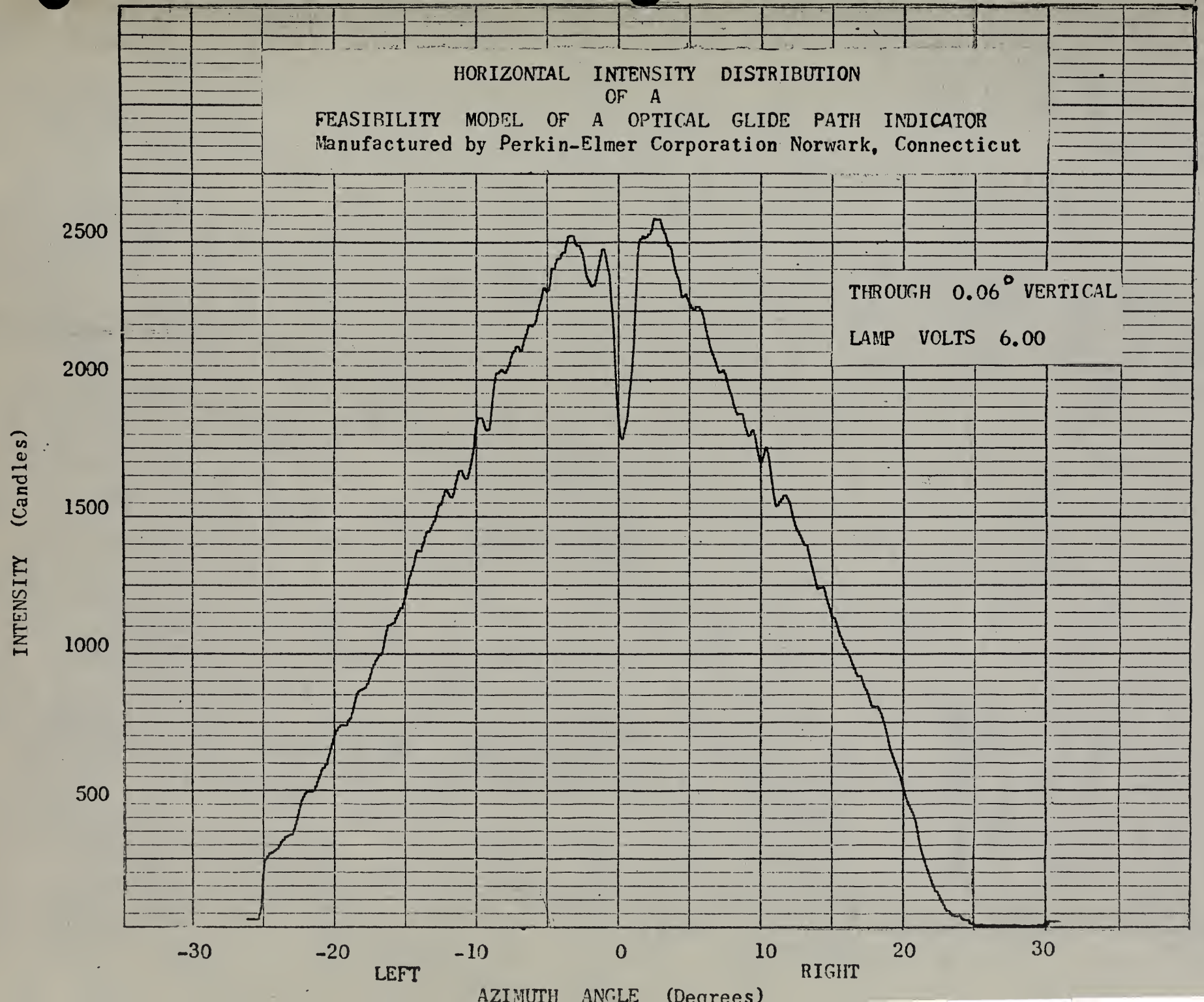
Several tests have been made of the performance of the transmissometer calibrator in an effort to determine the cause of a systematic error which has been observed recently. After a number of checks, the systematic error was traced to a badly misaligned light source. During the checks a system of aligning the calibration points using a transit and a mirror was worked out and used for aligning the calibration positions. This system provides considerably better accuracy in alignment than the method of using the shadow of the photocell originally used.

e. Personnel.

Mr. Richard L. Woodcock, GS-5, and Mr. James E. Freiheit, GS-3, are now on full time duty, changing from WAE status upon completion of the school year.

Mr. Morton R. Carrothers, GS-5, who was employed on a WAE basis while he attended school, graduated this spring and resigned on June 21, 1957 to take a position in private industry.


VERTICAL INTENSITY DISTRIBUTION
OF A
FEASIBILITY MODEL OF A OPTICAL GLIDE PATH INDICATOR
Manufactured by Perkin-Elmer Corporation Norwark, Connecticut
THROUGH ANGLES AS INDICATED.
LAMP VOLTS 6.00
+5°H
+15°H
INTENSITY (Candles)
2500
2000
1500
1000
500
-.32
-.24
-.16
-.08
0
.08
.16
DOWN
UP
ELEVATION ANGLE (Degrees)


HORIZONTAL INTENSITY DISTRIBUTION
OF A
FEASIBILITY MODEL OF A OPTICAL GLIDE PATH INDICATOR
Manufactured by Perkin-Elmer Corporation Norwark, Connecticut
THROUGH 0.06° VERTICAL
LAMP VOLTS 6.00
INTENSITY (Candles)
2500
2000
1500
1000
500
-30
-20
-10
0
10
20
30
LEFT
RIGHT
AZIMUTH ANGLE (Degrees)